Versatile Thermal Desorption

20-Years of Progress

Enviro-Klean Remediation Group, Inc.

www.enviroklean.com

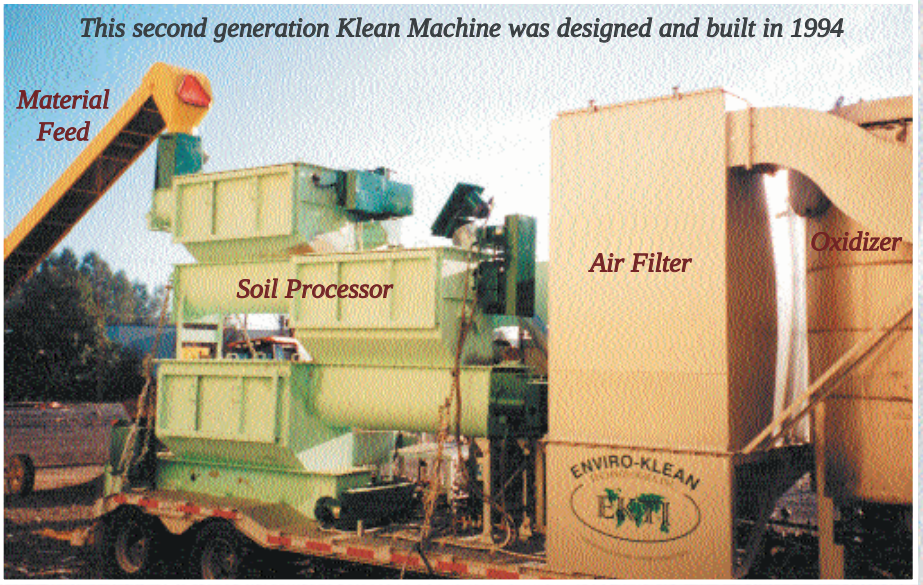
Enviro-Klean - 1980's to Present

Enviro-Klean's Roots

Back in the 1980's, manufacturers of asphalt plants began modifying their equipment to remediate hydrocarbon contaminated soils. The process was effective, however, fuel consumption and undesirable air emissions presented significant challenges.

As a result, a group of engineers joined forces under the name Enviro-Klean and began to explore alternate soil heating methods. They created the unique Enviro-Klean soil curtain design, which has been modified and improved through 4 generations.

Each new enhancement has increased the throughput, reduced energy consumption and improved air emissions. Today's model, the KM-4, is a testimony to the company's unceasing pursuit of perfection.



This second generation Klean Machine was designed and built in 1994

Certified Engineering and Manufacturing

Enviro-Klean equipment is engineered and manufactured in North America, and meets UL, CSA and European CE standards.

All machine components are designed for years of productive service. (The KM-2 pictured above was built in 1994 and is still in operation.) The drives and gear boxes used to power the screw conveyors and augers are top-of-the line Eurodrive and Baldor. The electronics are Siemens. The fuel system is Eclipse. The heavy-duty trailers feature air-ride suspensions.

Enviro-Klean is committed to providing competitive, state-of-the-art thermal remediation equipment that meets or exceed the toughest environmental standards world-wide.

For Additional Information on Thermal Desorption

The US Navy has commissioned hundreds of clean-ups, and has complied an intensive analysis of this technology, titled "Application Guide for Thermal Desorption Systems." It includes the following topics:

1. When to Use Thermal Desorption
2. Design and Performance Characteristics
3. Cost Data and Project Estimating Methodology
4. Regulatory Compliance Issues
5. Case Studies

You can review a copy of this report on the Enviro-Klean website at: www.enviroklean.com/USNavyReport

How Does It Work?

The Enviro-Klean thermal desorber is effective for removing hydrocarbon contamination from the soil.

Hydrocarbons volatilize when heated to their boiling point and subsequently convert to water vapor and carbon dioxide in a thermal oxidizer. The net result is reusable clean soil.

What Can it Clean?

The Enviro-Klean thermal desorber can clean gasolines, jet fuel, kerosene, diesel, lube oil…virtually any petroleum product.

In addition, with modifications, these versatile machines can clean soil containing pesticides, chlorinated compounds, plus recover entrained oil in drill cuttings.

Patented Soil Processor Design

The Patented Enviro-Klean Processor

Thermal desorption machines share three common features:

- a processor for heating the soil to release the contaminants,
- a oxidizer or condenser for removing the organics,
- a baghouse for containing the particulate.

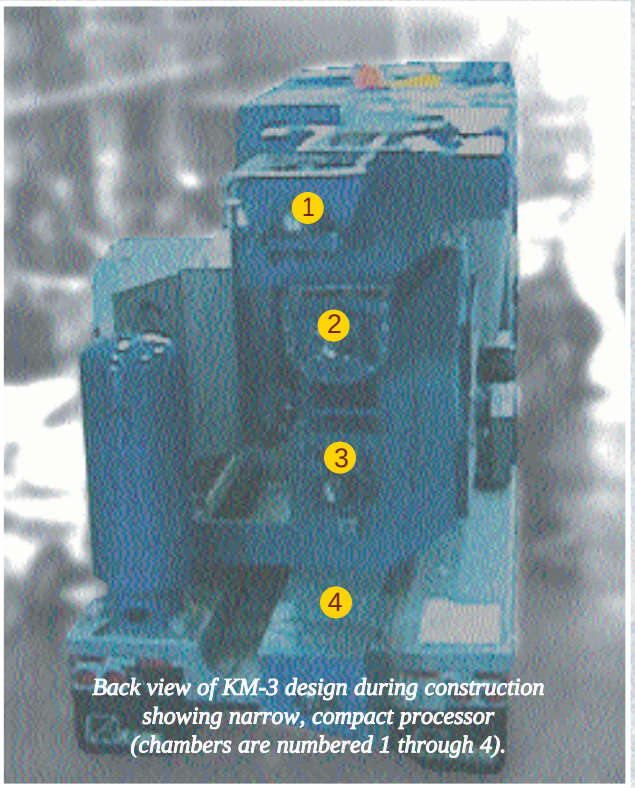
Most thermal machines use a double-shell rotary drum to heat and volatilize the contaminants. The residence time for soil in the drum averages 6 to 12 minutes—depending on soil type, moisture, contaminant, etc.

Enviro-Klean has a patented soil-curtain processor with an average residence time of about one minute. Contaminated soil falls in thin layers between the processor chambers—which allows for maximum heat transfer between the heated air and the soil.

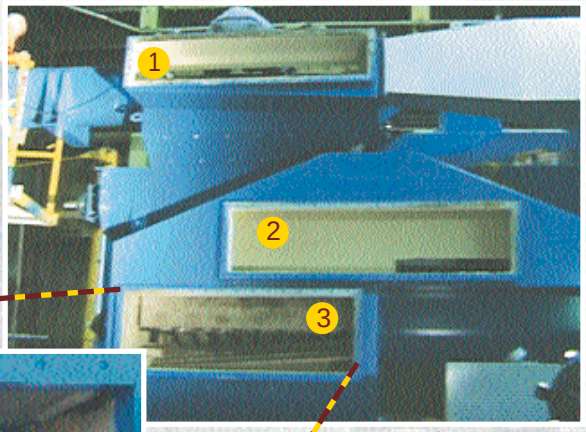
There are three primary savings with this system:

- less energy is required to heat the contaminants,
- soil moves through the processor faster which allows the Enviro-Klean machine to do the same job as one twice its size,
- the airstream is considerably smaller making it easier to control.

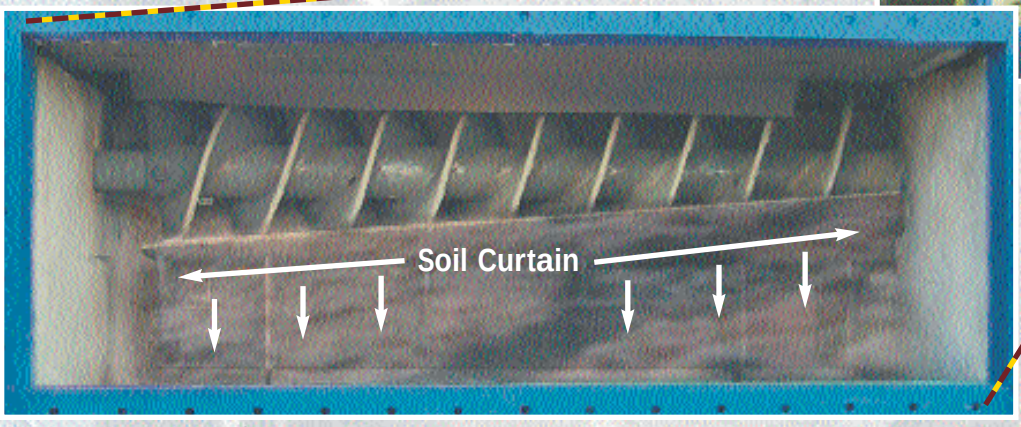
The net result is Enviro-Klean's ability to put all three of the necessary thermal desorption components on a single highway-legal trailer—making the system smaller, less expensive to operate and significantly reducing the capital cost.



Back view of KM-3 design during construction showing narrow, compact processor (chambers are numbered 1 through 4).



Side view of a KM-3 design during construction showing three of the four processor chambers.



Inside view of a processor chamber showing the screw, trough, and drop zone. Soil cascades down through the processors, while heated air volatilizes the contaminants.

Enviro-Klean KM-4
The Standard for Fuel Efficiency

Patented Processor Saves 50% on Fuel Costs

Traditional rotary kiln thermal desorbers use twice as much fuel for the same throughput as the KM-4.

Here is how the KM-4 design squeezes every drop of potential from its burner fuel.

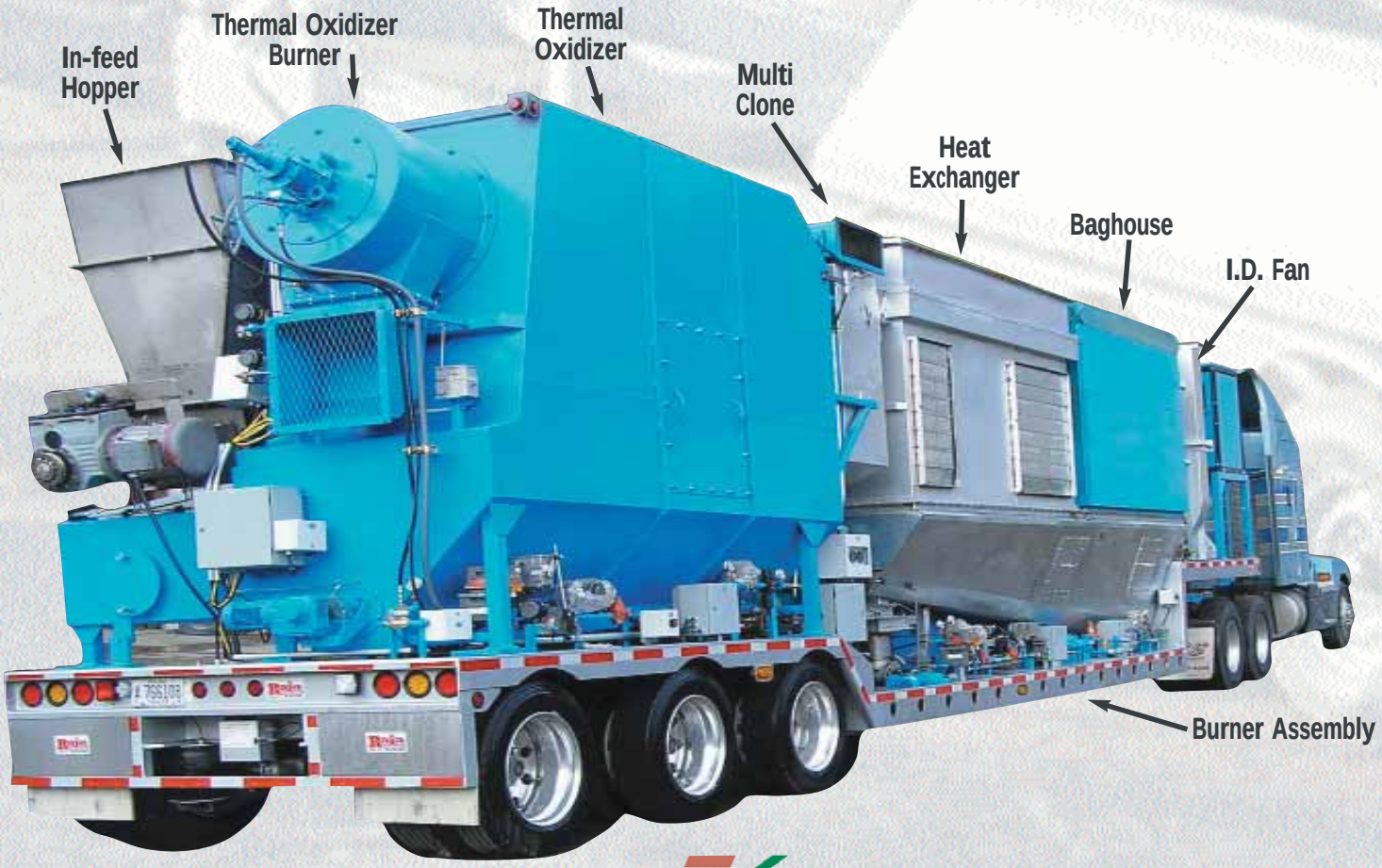
- The processor and thermal oxidizer walls are foam insulated, which is up to 3 times more effective than hard refractory. Radiation losses are minimal.
- The cascading soil design helps to volatilize the hydrocarbons at 30% lower airstream temperatures.
- And since the airstream is half the volume of a rotary kiln, less energy is required to destroy the hydrocarbons in the thermal oxidizer, and less energy is needed to cool the air prior to the baghouse.

The result of these design enhancements provides today's thermal remediation market with the fastest throughput, the lowest operating cost, and the most advanced options for remediating difficult hydrocarbon contamination.

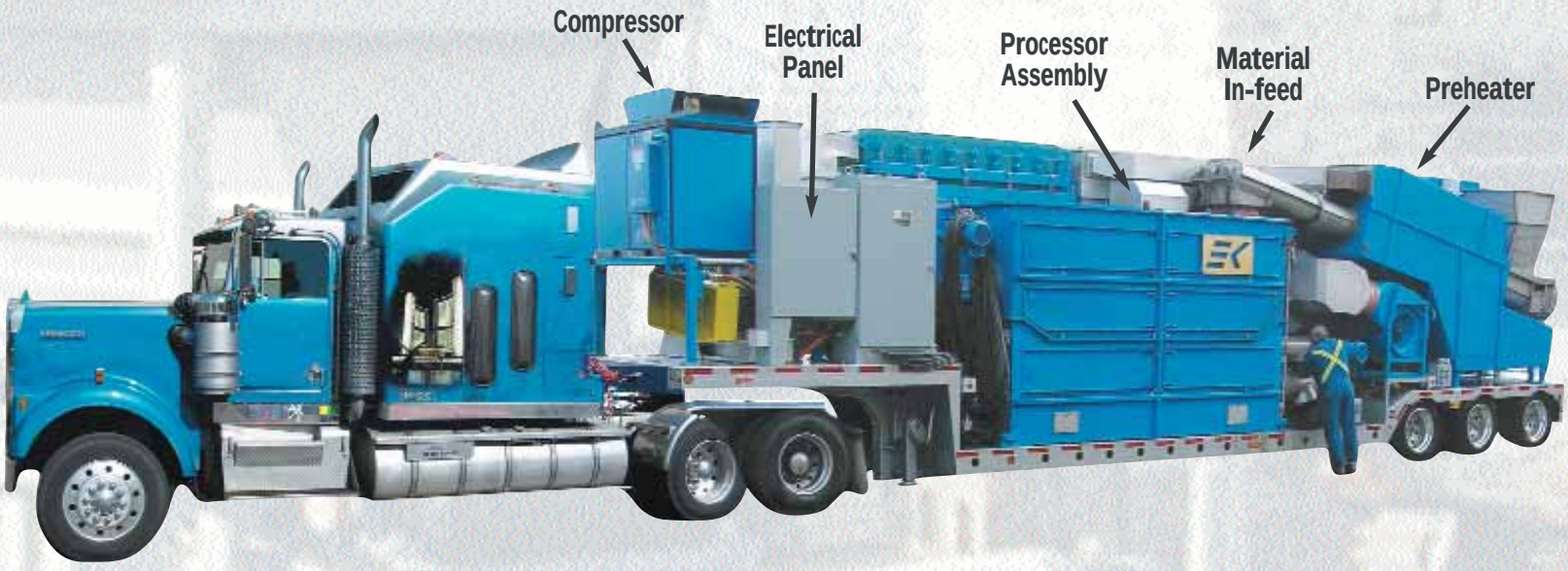
KM-4 DIMENSIONS*

Transport:	• Highway-legal on most commercial transport roads world-wide.
Trailer mounted:	• Includes material processor, thermal oxidizer, heat exchanger and baghouse
Trailer Length:	• 16 meters (53')
Equipment Height:	• 4 meters (13'2")
Trailer Width:	• 2.5 meters (8'2")
Total Weight:	• 33 tonnes (73,000 lbs)

***Note**: Due to on-going product upgrades, specifications and designs are subject to change without notice. Items shipped may differ from those described in this catalog.*



Enviro-Klean KM-4
Portable and Reliable



The Ultimate, High-Capacity Portable Thermal Desorber

The Enviro-Klean KM-4 is designed to minimize non-productive time. For faster mob/demob, the width and height dimensions are within North American and European road regulations. The trailer connects to any heavy-duty truck and is immediately ready for transport.

Set-up is straightforward. Unlike rotary kilns, there is no cumbersome ductwork to connect, and no large cranes needed to position the skids. Instead, the trailer is towed by the truck to a suitable, reasonably-level site. Then a few smaller components, notably the material feed and discharge system, are set in place and the equipment is ready for operation.

Cost-Effective for Smaller Projects

The KM-4 is especially effective for smaller remediation projects and rapid turn around times because it can be set up in less than a day. Competing equipment often requires a week or more, which adds significantly to the project cost and manpower requirements.

When small projects are time-consuming and costly, the contaminated soil is frequently trucked to a central site or a landfill—relocating the problem elsewhere and necessitating new fill material. This option is environmentally unfriendly and potentially dangerous.

KM-4 SPECIFICATIONS*

Nominal Feed Rate:	• 18-27 tonnes (20-30 tons) per hour
Contaminants:	• Hydrocarbons to 25,000 mg/kg and to Carbon Chain 40 at reduced throughput
Moisture:	• 20% maximum recommended (<15% preferred)
Processor Temp:	• 315-930°C (600-1700°F)
Fuel:	• Propane, natural gas or #2 fuel oil
CO:	• <100 ppm to non-detect
VOCs:	• Meets legal requirements for destruction (99% to non-detect)
Thermal Oxidizer:	• Direct Thermal 1-2 seconds residence time @900°C (1650°F)
Soil Classification:	• ASTM D2487-83, GW, GP, SW & SP

Petroleum Contaminated Soils Cleaned to:
MTC Act Table V Class 2 Levels
**Under controlled conditions*

Note: Throughput varies depending on soil moisture, soil type, contaminant type and level. See the Enviro-Klean website for additional information.

Training - Service - Warranty

Training

Enviro-Klean equipment is easy to learn and manage. It can be run by one operator and helper.

Training is available when the machines are tested prior to shipping, and include a comprehensive training manual for reference.

All the startup and shutdown controls are at a single station, and include temperature monitors for various processor chambers, the baghouse inlet, and the thermal oxidizer.

The machine can be operated in manual, or automatic mode.

Service

Enviro-Klean machines are built from heavy duty components, and with proper maintenance, seldom require more than regular greasing and inspection of moving parts.

They are shipped with a detailed service manual, and require approximately 2 hours of service for every 24 hours of operation.

Machine controls feature readily-available, off-the-shelf components, with an emphasis on quality.

When necessary, a factory rep will travel to the machine jobsite to inspect and repair the equipment.

The KM-4 control house offers the ultimate in air-conditioned comfort. Dual touch screen monitors allow the operator to view all important machine functions simultaneously, and at the same time, have a clear line-of-sight to all the material feed and discharge processes.

Equipment Warranty

Enviro-Klean warrants to the original buyer that all new equipment and material manufactured or designed by it shall be free from material defects in design and fabrication for a period of one (1) year from the date of shipment.

Production Warranty

Enviro-Klean warrants the soil plant production to meet the noted production rate subject to the following criteria: oil contamination in the soil not to exceed 80% of the processor and oxidizer fuel load, burner fuel to be natural gas, liquid propane or #2 fuel oil, plant operation at 150 meters (500') elevation or less, soil gradation to be equal or less than 33% fine material (equal to 63 micrometer), density of the soil to be equal to or greater than 1.09kg/M^3 (85 lb/ft^3), soil specific heat equal or less than .22, and when the plant is set up and operated according to the sellers instructions

KM Options and Feed System

KM-4(EU) - 380V, 50Hz Option

North American KM-4 machines are designed for 460V, 60Hz electricity. For Europe a 380V, 50Hz system is available.

KM-4(MF) - Multi-Fuel Option

The basic KM-4 operates on propane or natural gas. It can be optionally modified to use #2 fuel oil, and also be configured as a combination gas/oil system.

KM-4(GS) - Genset Option

The KM-4 can be connected directly to grid power, or optionally to an appropriately-sized generator set.

KM-4(FS) - Feed System Option

It is highly recommended that the KM-4 is used together with the integrated feed, trommel screen system designed to blend, dry, and meter the feed stock. However, the KM-4's electrical and electronic system can be configured to manage other material feed designs.

KM-4(SS) - Stainless Steel Option

Although all high temperature components of the KM-4 (processor, oxidizer, heat exchanger, ducting) are manufactured using appropriate grades of stainless steel, for corrosion resistance or when running chlorinated compounds, an all stainless machine can be the best option.

KM-4(HC) - Scrubber Option

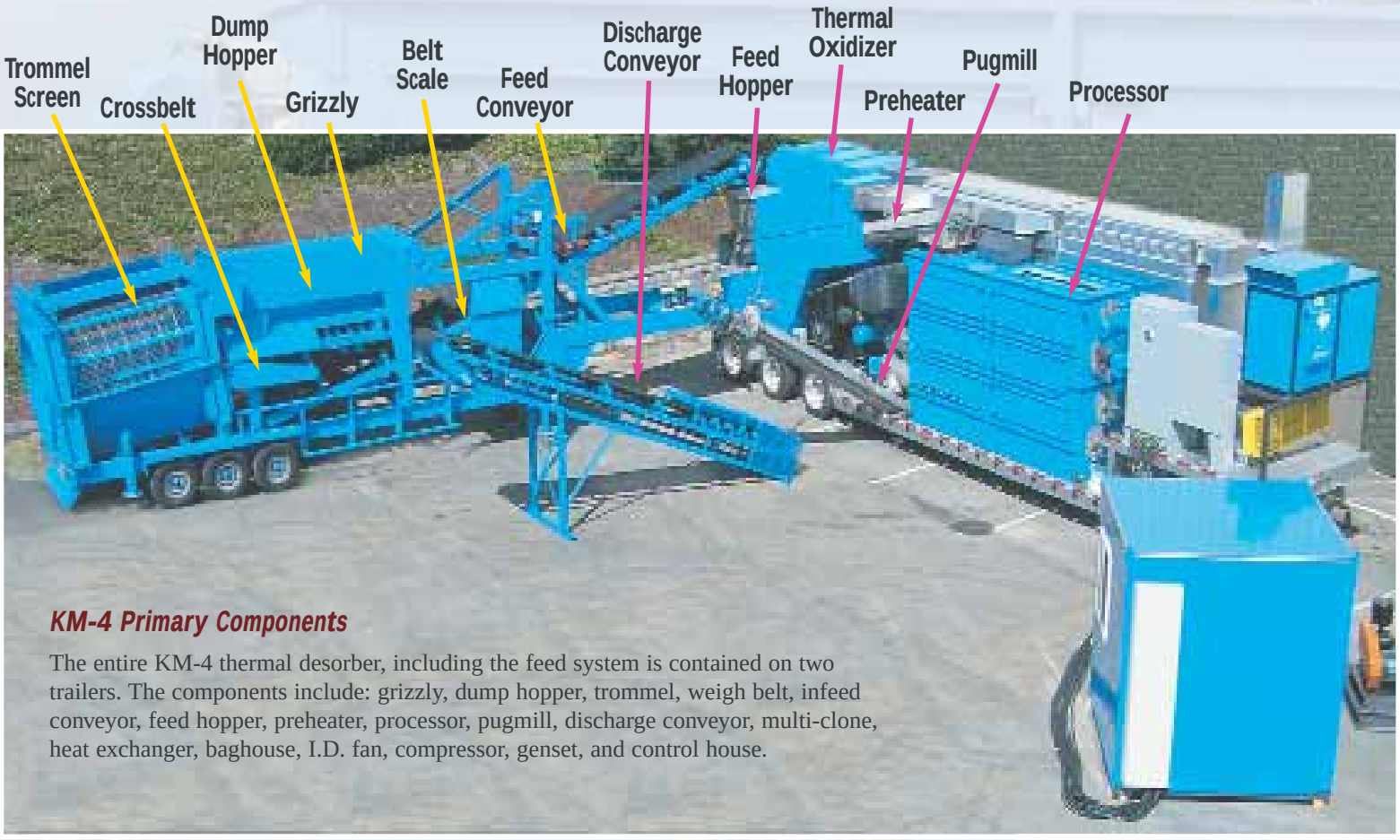
Halogenated compounds may require additional treatment in a scrubber system to remove contaminants like chlorine, fluorine, or bromine from the vapor stream. The KM-4 is fabricated with provision for a scrubber to be added—either when the machine is ordered from the factory, or later when required.

KM-4(OR) - Oil Recovery Option

When the feed material has hydrocarbon concentrations above 100,000ppm, it can be cost-effective to select the oil recovery option. This model condenses the airstream and collects the volatilized hydrocarbons for reuse.

Feed and Discharge Conveyor - Pictured here is a typical custom feed and discharge system that works with all Enviro-Klean models. It includes a 5 yard hopper, a <5mm (2") trommel screen, and a telescoping feed conveyor that reaches to the in-feed hopper on top of the KM-4. The discharge conveyor is 7 meters long (23'), and carries soil from the pugmill away from the machine. All the components fit on a single highway-legal trailer for transport.

KM-4 Operation
Feed Stock Preparation



KM-4 Primary Components

The entire KM-4 thermal desorber, including the feed system is contained on two trailers. The components include: grizzly, dump hopper, trommel, weigh belt, infeed conveyor, feed hopper, preheater, processor, pugmill, discharge conveyor, multi-clone, heat exchanger, baghouse, I.D. fan, compressor, genset, and control house.

Feed Stock Preparation

The KM-4 feed system is compact and mounted on a single highway-legal trailer. Various feed and discharge components are stored or folded to facilitate transport. This custom-designed system screens and blends feedstock before allowing it to enter the soil processing section of the equipment.

A <10cm (4") **grizzly** keeps oversized material out of the dump hopper. The debris is cleared remotely by the loader operator. A **cross belt** conveys material to the <5cm (2") rotating **trommel**, which aerates, blends and reduces moisture before screening the material onto the **feed conveyor**.

En route to the processor, the feedstock is first weighed on a computerized **belt scale**, and then deposited into the **feed storage hopper**. This hopper is fitted with an automatic sensor that both controls the feed rate and also maintains a front-end material seal.

End view of feed trailer system showing the inside of the trommel screen with the opening into the dump hopper

KM-4 Operation
Contaminated Feed Handling

Contaminated Feed Handling

The KM-4 handles contaminated material efficiently by heating it quickly to volatilize the hydrocarbons. This starts in the triple-purpose **pre-heater**. It meters the flow rate into the processor; it draws excess heat from the **thermal oxidizer** to begin raising the material temperature, and the twin screw design further mixes and blends the feed material.

Contaminated material passes from the top to the bottom of the **processor** through a series of heavy-duty screw conveyors. As the material drops between chambers, the finer particles, which have the highest hydrocarbon contamination, are exposed to the crosscurrent flow of hot air from the burner.

After passing through the processor, the cleaned soil is discharged into the **pugmill**, where it is mixed with water for cooling and dust control. The pugmill, in turn, deposits the cleaned material on to the **discharge conveyor** that stacks it for immediate or future use as clean backfill.

At the junction between the lowest processor screw conveyor and the pugmill is a material temperature sensor, which controls the feed rate for the entire system. This sensor maintains a preset discharge temperature and makes certain the contaminated material is cleaned to environmental standards.

Particulate Handling

Because the feed material is thoroughly dried to volatilize the hydrocarbons, there is always a particulate component to the airstream. It is highest with finely textured materials like clay.

This particulate must be removed before the airstream is filtered back into the atmosphere, and the KM-4 has a number of tightly engineered systems to extract the particulate from the air, clean it, and discharge it with the balance of the treated material.

Contaminated Particulate

Some feed material exits the processor as particulate in the air stream. Approximately 90% is collected by the **multi-clone** and conveyed back to the processor for further hydrocarbon removal. Multi-clones are more efficient than cyclones and occupy about one-quarter of the space for a given particulate removal requirement. The KM-4's multi-clone removes nearly all the particulate down to 50 microns.

End view of the Enviro-Klean processor Contaminated feed enters the top of the unit and cascades down through a series of chambers until the material is cleaned. On the lower left is a gas/oil processor burner.

Clean Particulate Handling

The **thermal oxidizer** eliminates all hydrocarbons from the air stream, however the airstream has a small amount of particulate that is conveyed to the pugmill for discharge.

The heat exchanger/baghouse also collects a small amount of clean particulate, and this is also conveyed to the pugmill for rehydration and discharge.

The material handling systems described above make certain that contaminated materials are cleaned to environmentally safe standards and that all material discharge from the KM-4 is immediately suitable for backfill.

KM-4 Operation
Air Flow

The Air Flow

Overall, the KM-4 uses about half the energy to clean the same volume of soil compared with a rotary kiln. This is accomplished by carefully manipulating the airstream to extract maximum heat transfer from the hot air to the material, the volatilized hydrocarbons, and the air-cooling and cleaning system.

Heating the Material

The primary system burner is located at the base of the material processor, and operates on gas or oil. It has a dedicated combustion chamber that assures proper development of the flame and utilization of the combustion air. The entire processor is completely foam insulated to minimize radiant heat loss. An I.D. fan pulls the air through the system.

As the hot air travels through the screw conveyor arrangement in the processor, most of the heat is transferred to the material. This volatilizes the water and hydrocarbon liquids, which are ducted from the top of the processor to the thermal oxidizer by way of the multi-clone.

Destroying the Hydrocarbons

The thermal oxidizer has a secondary burner that raises the airstream temperature to 900C (1650F) in order to destroy the hydrocarbons liberated from the feed material.

In other systems, the hot air is cooled, cleaned and then discharged from the system. The KM-4 is unique because it uses a patent pending preheater that absorbs the thermal oxidizer's hot air to raise the temperature of the in-coming feed material.

Air Cooling and Cleaning

After exiting the thermal oxidizer, the hot air is cooled in an air-to-air heat exchanger. This device requires no energy except for a fan to supply ambient air to the process.

The heat exchanger is required to protect the baghouse filters, which in the KM-4 are a recent innovation that allows high temperature pleated elements. The pleated filters significantly reduce the space requirements of the baghouse while delivering the same particulate removal as traditional filter systems.

The thermal oxidizer, heat exchanger, and baghouse are about half the size of conventional thermal systems with the same throughput because less heat is required to raise the material temperature and volatilize the hydrocarbons.

The KM-4 uses the latest generation of high-temperature, pleated filter elements to retain particulate within the system. The bags are pulse-jet cleaned and the particulate is discharged and rehydrated together with the cleaned feed material.

Heated air from the thermal oxidizer is cooled by a proprietary heat exchanger prior to entering the baghouse. A VFD-controlled blower provides the correct volume of cooling air to the system.

KM-4 Operation
System Controls

System Operation

The KM-4 employs up-to-date control technologies for trouble-free, efficient operation of the equipment. These include touch screens for the operator, remote temperature and pressure sensors, and motors equipped with variable frequency drives.

Control House

The air-conditioned control house is designed for the comfort, safety and efficiency of the operator. In it, the operator has complete control over the entire system, from material feed and discharge, to combustion air input and flue gas exit.

The KM-4 is capable of fully automatic operation, which optimizes the feed rate and the fuel usage. The entire system is controlled by the discharge soil temperature, which is set by the operator and based on prevailing environmental standards.

Motors are powered by variable frequency drives which allow incremental adjustments to the feed material and air flow rates in all parts of the equipment.

The KM-4 has more than 20 temperature and pressure sensors and other thermocouples that monitor the various functions of the system. Together with the VFDs, they help the operator achieve the highest possible throughput with the least consumption of fuel.

System Power

Either grid power or a genset is used to power the system. For North American applications, the power supply is 460V, 60Hz. For Europe, it is 380V, 50Hz. The genset is sized to power all the KM-4 and feed system motors, with extra capacity for lighting and incidental tools.

Similarly, the air compressor which supplies air to the pulse-jet baghouse, also has additional capacity for burner operations and other air-powered equipment.

The computer system includes a backup plus a means for logging all the input and output data received from the various drives, thermocouples, and other sensing devices.

In all, the KM-4's control system is the finest available today. It uses world-leader, Siemens components to assure dependable performance and product support world-wide.

The variable frequency drives for all the unit's motors are housed within the control house and cooled by a dedicated air-conditioner. The image at the right shows the quick disconnect panel on the outside wall of the control house.

All electrical connections are designed to withstand extremes of temperature and the rigors of on-site conditions. This set of connectors integrates the feed system motors with main processing unit.

Enviro-Klean Test Results

Pass All Environmental Standards

SOURCE EMISSIONS TESTS

The following KM-3 tests were conducted in accordance with Environmental Protection Agency (EPA) standards as defined in document Title 40, Code of Federal Regulations, Part 60 (40 CFR 60), Appendix A, Methods 1, 2, 3A, 4, 5 and 25A, and Puget Sound Air Pollution Control Agency (PSAPCA) Method 5 back-half extraction procedures.

The independent testing laboratory, AMTEST, of Washington State ran three (3) 60-minute tests. The TDU processed 11-12 CY of soil per hour during the tests (16 to 18 tons). EPA Method 25A was performed to quantify emissions of volatile organic compounds (VOC) as THC using a flame ionization analyzer (FIA). PSAPCA back-half analysis procedures were used for consider-able matter analysis.

The government requirements and results of these tests are shown below.

Air emissions meet or exceed all North American standards permitable in all jurisdictions.

Analytic Report - Northwest Labs, Lot#151785

Langley, BC Nov. 29 - Dec 8, 2001

Soil Test Results	KM3 HT	Enviro Klean Technologies Inc.		
Analyte (given in dry weight)	**Units**	**Results Before**	**Results After**	**Detection Limit**
		Gasoline		
Mono-Aromatic Hydrocarbons - Soil		**Sample #1 - B**	**Sample #1 - A**	
Benzene	ug/g	<0.02	<0.02	0.02
Toluene	ug/g	5.32	<0.02	0.02
Ethylbenzene	ug/g	14.1	<0.02	0.02
Total Xylenes (m,p,o,)	ug/g	184	<0.02	0.02
Styrene	ug/g	<0.02	<0.02	0.02
Volatile Petroleum Hydrocarbons - Soil				
VHs 6-10	ug/g	1030	<1	1
VPHs	ug/g	837	<1	1
Extractable Hydrocarbons - Soil				
EPHs 10-19	ug/g	1340	<10	10
EPHs 19-32	ug/g	<10	<10	10
		Diesel		
Extractable Hydrocarbons - Soil		**Sample #2 - B**	**Sample #2 - A**	
EPHs 10-19	ug/g	9850	14	10
EPHs 19-32	ug/g	2840	20	10
		Lube Oils		
		Sample #3 - B	**Sample #3 - A**	
EPHs 10-19	ug/g	771	42	10
EPHs 19-32	ug/g	10900	97	10
		Composite HC		
		Sample #4 - B	**Sample #4 - A**	
EPHs 10-19	ug/g	751	11	10
EPHs 19-32	ug/g	14400	84	10
		Grab Sample		
		Sample #5 - B	**Sample #5 - A**	
EPHs 10-19	ug/g	1330	<10	10
EPHs 19-32	ug/g	12660	13	10
		Creosote		
		Sample #6 - B	**Sample #6 - A**	
EPHs 10-19	ug/g	5710	47	10
EPHs 19-32	ug/g	9090	474	10
		Fines	Fines	Fines
		Sample #1 Diesel	**Sample #2 Lube Oils**	**Sample #3 Creosote**
EPHs 10-19	ug/g	<10	<10	<10
EPHs 19-32	ug/g	<10	<10	<10
Particulate: <6mg/m3 THC: <3/ mg/kg				

Special Financing

Enviro-Klean thermal desorption machines offer significantly greater savings on the capital and operational costs over similar equipment in the marketplace.

These savings are attributable to the innovative processor design and to their manufacture in Canada.

The Canadian Government, through the Export Development Corporation (EDC) has agreed to back up to 85% of a KM-4 purchase O.A.C.

You can get more information on this ownership advantage at the following websites: www.edc.ca and www.northstar.ca.

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